ISO TC184/SC4/WG8 N206

Date: 1999-10-29

Supersedes ISO TC 184/SC4/WG8 N202

ISO/CD 15531-31

Manufacturing management data exchange: Resources usage management : Resources information model basic concepts

ABSTRACT:

This document provides a presentation of the parts 3x of the of the MANDATE standard . This series address the representation of data related to the resources usage management in a production process. It also gives some indication on the relationships with other parts of the standards ISO 15531.

KEYWORDS:

Manufacturing, Production, Resources, Data Exchange, ISO 10303, ISO 13584, Enterprise Integration, Manufacturing Process

COMMENTS TO READER:

This document has been reviewed and noted by ISO TC184 /SC4 Secretariat and has been determined to be ready for this ballot cycle (second CD ballot).

Project Leader: Dipl.-Ing. Roland Jochem	**Project Editor:** Jean-Jacques Michel
Address: IPK Berlin	**Address :** CETIM
Pascalstrasse 8-9 10587 Berlin Germany	52 avenue Felix Louat 60304 SENLIS France
Telephone: +49/30 39006195	**Telephone:** + 33 3 44 67 33 15
Telefacsimile:+49/30 3932503	**Telefacsimile:** +33 3 44 67 34 40
Electronic mail: roland.jochem@ipk.fhg.de	**Electronic mail:** jean-jacques.michel@cetim.fr

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Foreword

The International Organisation for Standardisation (ISO) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organisations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards (DIS) adopted by technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75% of the member bodies casting a vote

This part of ISO 15531 was prepared by the Technical committee ISO/TC184 *Industrial automation systems and integration,* Sub-Committee 4 *Industrial data.*

ISO 15531-3x series of parts consists of the following:

- Part 31 : Resources information model basic principles
- Part 32 : Conceptual model for resources usage management data
- Part 33 : Conformance testing

Introduction

Resources form the basis and technological foundation of any manufacturing system. The efficient use of resources is the main goal of cost management which, in turn, directly contributes to market success.

Different aspects of the resources depend on the viewpoint being considered. The choice of a specific aspect is a way of reducing complexity.

Therefore, future concepts for business process development and resource management require:

— an integrated view of the complete set of business processes and the relevant resource management activities;

— an integrated resource management including interfaces to external manufacturing unit.

NOTE – external-manufacturing unit may be for example suppliers or subsidiaries.

Resource attributes and the required capabilities and capacities for manufacturing processes have to be described by data modelling, so that they can be communicated and used more efficiently for resource usage management. The means of information representation should therefore be standardized.

EXAMPLE – resources attributes may be for example capability, capacity, and status.

In this standard the only aspect under consideration is the management of resources usage. The objective is to describe the resource management information to enable an unhindered flow of information between all systems and humans involved.

Industrial automation systems and integration — Industrial data — Industrial manufacturing management data exchange — Part 31: Resource usage management data: Resources information model basic principles.

1 Scope

1.1 Scope of ISO 15531-3x series

The scope is to develop the models, and attributes capable of residing in an industrial manufacturing company's resource database which are to be used by manufacturing management for the purpose of resource usage management.

The following are within the scope of ISO 15531-3x series:

— the representation of resources information including capacity, monitoring, maintenance constraints and control ;

— the exchange and sharing of resource information including storing, transferring, accessing and archiving.

The following are outside the scope of ISO 15531-3x series:

— representation and exchange of product information;

— representation and exchange of computer-interpretable parts library information;

— electronic representation for exchange of cutting tool data;

— technical maintenance information such as those included in devices repair, operation and maintenance manuals

1.2 Scope of ISO 15531-31

ISO 15531-31 is an introduction to the ISO 15531-3x series of part of ISO 15531, describes the resources information model, and provides the main principles used in this series of parts of ISO 15531.

The following are within in the scope of this Part of ISO 15531:

— general overview of the parts 15531-3x series;

— definitions of terms used;

— fundamental principles used for conceptual model of resource usage management data;

— description of the resources information model (RIM);

— derivation process of identification and description of resources;

— structure of the standard and relationships between this series of parts and the others series of parts the standard is composed;

— use of standard (informative).

The following are out of the scope of this part of ISO 15531:

— detailed description of the resource information model;

— EXPRESS description of the model and related entities;

— definition of detailed level concepts and entities;

> NOTE - Those three items are developed in the part 32 of ISO 15531 : *Conceptual model for resources usage management data.*

2 Normative references

The following standards contain provisions, which, through reference in this text, constitute provisions of this part of ISO 15531. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 15531 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards

— ISO 10303-1: 1993, *Industrial automation systems and integration- Product data representation and exchange - Part 1: Overview and Fundamental Principles*

— ISO 10303-11: 1994, *Product data representation and exchange - Part 11: Description methods: The EXPRESS language reference manual*

— ISO 10303-21: 1995, *Product Data Representation and Exchange - Part 21: Clear text encoding of the exchange structure.*

— ISO 10303-22: 1995, *Product Data Representation and Exchange - Part 22: Standard data access interface.*

— ISO 10303-31:1994, *Product Data Representation and Exchange - Part 31: General Concepts*

— ISO 10303-41: 1994, *Product Data Representation and Exchange - Part 41: Fundamentals of product description and support.*

— ISO 10303-49: 1997, *Product Data Representation and Exchange - Part 49: Process structure and properties.*

— ISO 13584-1:1997, *Industrial automation systems and integration - Parts library - Overview and fundamental principles.*

— ISO DIS 15531-1: 1999 *Industrial manufacturing management data – Part 1: General overview*

— ISO FSIS 14258: 1998, *Industrial automation systems and integration - Concepts and rules for entreprise models*

— ISO/IEC 8824-1:1994, *Information Technology - Open Systems Interconnection - Abstract Syntax Notation One (ASN.1) _ Part 1: Specification of Basic Notation.*

— ISO/IEC 2382-24:1995, *Information technology - Vocabulary - Part 24: Computer-integrated manufacturing.*

3 Terms, definitions, and abbreviations

3.1 Terms defined in ISO 10303-1

This part of ISO 15531 makes use of the following terms defined in ISO 10303-1:

— conformance testing;

— data;

— data exchange;

— information;

— product;

— product data.

3.2 Terms defined in ISO 10303-11

This part of ISO 15531 makes use of the following terms defined in ISO 10303-11:

— entity.

3.3 Terms defined in ISO 15531-1

This part of ISO 15531 makes use of the following termes defined in ISO 15531-1:

— capability;

— capacity;

— construct;

— entreprise entity;

— model;

— process;

— resource.

— universe of discourse

3.4 Terms defined in ISO 14258

— enterprise;

— enterprise model

3.5 Other definitions

For the purposes of this part of ISO 15531, the following definitions apply.

3.5.1
attribute

a piece of information stating a property of an enterprise entity.

NOTE – The concept provided here to the broad concept of entity as defined in European standard ENV 12204. The term entity used in the definition provided by the ENV 12204 has been replaced here by entreprise entity as in ISO 15531-1 to avoid any confusion and inconsistency with the reserved term “entity” defined in ISO 10303. The usage of this concept has been limited to the area of concern of ISO 15531 in order to enable the use of the term “enterprise entity” instead of “entity”, and the field of application of the term attribute is restricted to enterprise entities.

3.5.2
business process

a partially ordered set of activities of an enterprise which can be executed to realise a given objective of the enterprise or a part of the enterprise to achieve some desired end-result.

3.5.3
classification

the process of arranging abstractions into a structure organised according to their distinguishing properties.

3.5.4
definition of resource characteristics

set of resources properties that are characterised by physical values.

NOTE - Those physical values may be qualitative or quantitative.

3.5.5
definition of resource views

classified set of resource views.

NOTE - Those resource view may be defined either by the user or catalogues.

3.5.6
generic resource

structure belonging to resource hierarchy and encompassing the common properties of several resources.

NOTE - The corresponding entity `generic_resource` includes a complete definition of the related attribute without link to actual value.

3.5.7
object

concept or a physical thing which may exist in the real world.

3.5.8
operation

the completion of an action or work element to realise a specific result.

3.5.9
order

a construct which represents the necessary input for a business process that co-ordinates and controls some other business process or activity.

3.5.10
property

a real world characteristic which is represented by either attributes or constraints.

3.5.11

resource characteristic

main property of a resource according to a given purpose.

NOTE 1 - In ISO 15531 resource characteristics are mainly related to the management of the manufacturing resources.

NOTE 2 - The resource characteristic is represented by the entity `resource_characteristic`.

3.5.12
resource configuration

set of properties of resource configured for a specific manufacturing task.

NOTE - The resource configuration is represented by the entity `resource_configuration.`

3.5.13
resource hierarchy

structure designed to enable a classification of resources.

3.5.14
resources information model (RIM)

model of information addressing management of resources usage.

3.5.15
resource status

set of properties of a given individual resource that are related to the state of the resource and provide feedback information on it.

NOTE - The resource status is represented by the entity `resource_status`.

3.5.16
resource view

specific set of resource characteristic associated to a given generic resource.

NOTE - The resource status is represented by the entity `resource_view`.

3.5.17
structure of resource characteristics

set of classified resource characteristics.

3.5 Abbreviations

For the purpose of this part of ISO 15531, the following abbreviations apply:

RIM resources information model

4 Overview of resource management universe of discourse

This series of parts refers to the resource usage management. Resources usage management includes resource configuration, capabilities and capacities as well as operation management, installation management and facilities management. It also includes quality features, maintenance features, and safety features.

> NOTE 1 – maintenance features are exclusively considered regarding the point of view of the resource management (e.g. availability).

Three different aspects must be considered about the resources:

— their description, their usage and their maintenance;

— the description of the functionality a resource is able to provide, its capacity and capability;

— the information model used to trigger, estimate and monitor the resource.

This series of parts clearly do not address the first item whether it is considered as raw material or intermediate product. That means that ISO 15531-3x series of parts do not address resources in term of product description as it could be made using ISO 10303. Resource information model described in this part includes neither the modelling of the resource shape nor the description of its usage in the meaning of its way of working.

> NOTE 2 - ISO 15531 does not describe the way of working of a drilling machine excepted in term of capability and capacity. The milling machine modelling in term of its component description is the domain of ISO 10303, ISO 13584 or "cutting tools" standards. ISO 15531-31 addresses only the management data of the milling machine.

The description of capacities and capabilities of the resources (the functionality) is modelled at a very generic level. That allows any modeller to use this generic model, eventually in conjunction with other standards (e.g. ISO 10303, ISO 13584), to make up a more precise resource model aimed at a specific industrial activity, or a specific function.

This series of parts of ISO 15531 deal with model, and attributes of data capable of being stored in an industrial company's resource database for the purpose of manufacturing management. They address the following data:

— performance metrics;

— input and output resources definition;

— capacity and capability;

— tools and application software needed in conjunction with specific activities;

— capacity of internal controls and intelligence;

— information input and output capability and capacity;

— standard references for resources;

— maintenance scheduling and monitoring;

— cost elements.

5 Structure of ISO 15531-3x series

ISO 15531-3x series of part on manufacturing resource usage management data is divided into three parts. Although they are strongly connected and related, this series of parts address specific concerns and are developed separately. A general overview provides principles and concepts to preserve consistency and to describe the relationships between them.

The numbering of the standard is the following:

— ISO 15531-31: Resources information model basic principles;

— ISO 15531-32: Conceptual model for resources usage management data;

— ISO 15531-33: Conformance testing.

Some of the information to be represented in ISO 15531-2x series of parts comes from the outside of the enterprise, and is used throughout the entire production cycle to be ultimately returned to the environment. In any case, data exchanged during the production cycle are strongly related to system management and to time and flow models as described. Part 31 describes the fundamental principles and gives an overview of the 15531-3x series. Part 32 describes the conceptual model for resource usage management data based on a special modelling concept and constructs and provides a resource information model (RIM). Part 33 describes the conformance testing procedure and results.

EXAMPLE – Environment includes suppliers, customers, subsidiaries, and others partners.

6 Fundamental principles

The conceptual model of resource management is a way for modelling resource management activities and the information required to perform these activities. Its objective is to provide a method for describing the usage management of resources in business processes and all related information.

Planning and managing resources relating business process to resource usage management requires:

— a representation of the information needed by the business process;

— a representation of the information about management activities necessary for planning and controlling the resources;

— a representation of the resource information and attributes;

Conceptual models of resource usage management require:

— the modelling elements;

— the modelling of information needed for processes and information about the processes required for performing the resource management activities.

NOTE - Modelling elements includes resources.

EXAMPLE –. Machines, software, data set, human, information

The following sections describe modelling concepts and constructs to represent these requirements and provide an outline of the structure and elements of a resource information model, which enable resource usage management.

6.1 Modelling Concept and Constructs

The representation of manufacturing business processes and related complex structures in a model requires a modelling language, which adequately represents the information, attributes, structures and processes needed for resource management.

A business activity is a purpose-driven change of one or more objects. These changes require direct or indirect planning and scheduling and are executed by resources, which own the needed capability.
Objects which are transformed by a resource are objects of the generic classes product (Product Development, Production,...), Order (Order Processing, Order Decomposition,...), Resource (Resource Planning, Resource Management, Maintenance,..) or their respective subclasses. An order, electronic software or human control does ordering and controlling resources.

The enabling information for a resource to execute the transformation is part of the resource description [1].

Each resource within a business process can be considered in the following manner (see Figure1):

— the first stage is the description of the object(s) (material or information, orders, products or other resources) to be transformed within the resource;

— the second stage describes the transformation during which the task itself is achieved;

— the third stage is of the description of the object(s), which have been transformed by the resource.

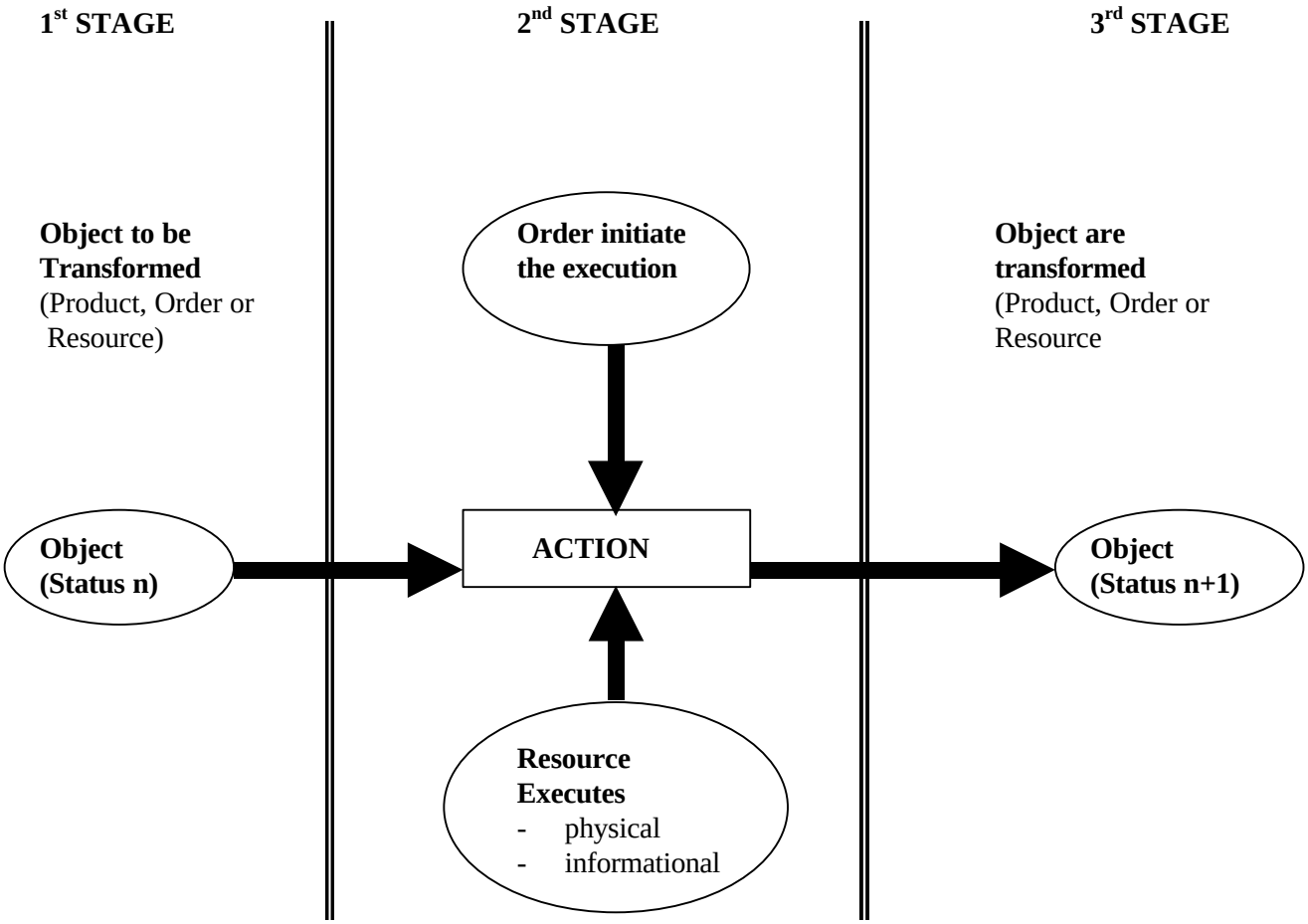

Figure 1 - Model for representation of business processes and structures [1]

6.2 Object and Resource Change State Sections

6.2.1 Input Section

Objects are subject to constraints prior to transformation. The input section, before transformation occurs, defines the format of object entries.

> NOTE - Usually there is more than one possibility accepted by the resource and, as a result, the definition of the constraints and attributes will be a list or a generic definition.

6.2.2 Transformation Section

This section represents the transformation capabilities and the capacity the resource is able to provide to the outside.

6.2.3 Output Section

Objects released from the resource are also subject to constraints. The output section relates transformed objects is defining under which form and with which support, the objects have to leave the resource (see 6.2.1 Input Section).

Representing the related and affected processes of resource usage management with the above described concept and constructs leads to the elements of a Resource Information Model enabling and supporting resource usage management.

6.3 Resource Information Model (RIM)

A complete representation of manufacturing resources, e.g. shape aspects, is not within scope of ISO15531-32. Only data relevant for decision-making regarding to the usage of resources, e.g. within process planning or job scheduling, are considered. In order to meet all tasks, the information model is structured in a modular way (see Figure 2).

The entity `resource` forms the central element within the schema. Each further description classifying or detailing a resource's characteristics is related to `resource`. The schema's entities can be clustered into logical units including:

— resource hierarchy ;

— structure of resource characteristics ;

— resource status;

— definition of resource views ;

— definition of resource characteristics
— resource configuration.

Instantiating `resource_group` and `generic_resource` can represent a resource hierarchy, which are both subtypes of `resource`. The recursive attribute `super_group to resource_group` enables the representation of multiple hierarchical layers of resources, e.g. a classification of cutting tools regarding to ISO 13399. A `generic_resource` is characterised by a complete definition of all related

attributes, but without link to actual values. The instances of `generic_resource` form the lowest level in a resource hierarchy. A `specific_resource` is the specification of a `generic_resource`, which is derived by assigning actual values to all resource-related attributes except attributes related to tasks, which require dynamic information. An `individual_resource` represents physical available manufacturing resources and enables a relation to dynamic information. The `individual_resource` inherits all attributes respectively values from the relating `specific_resource`.

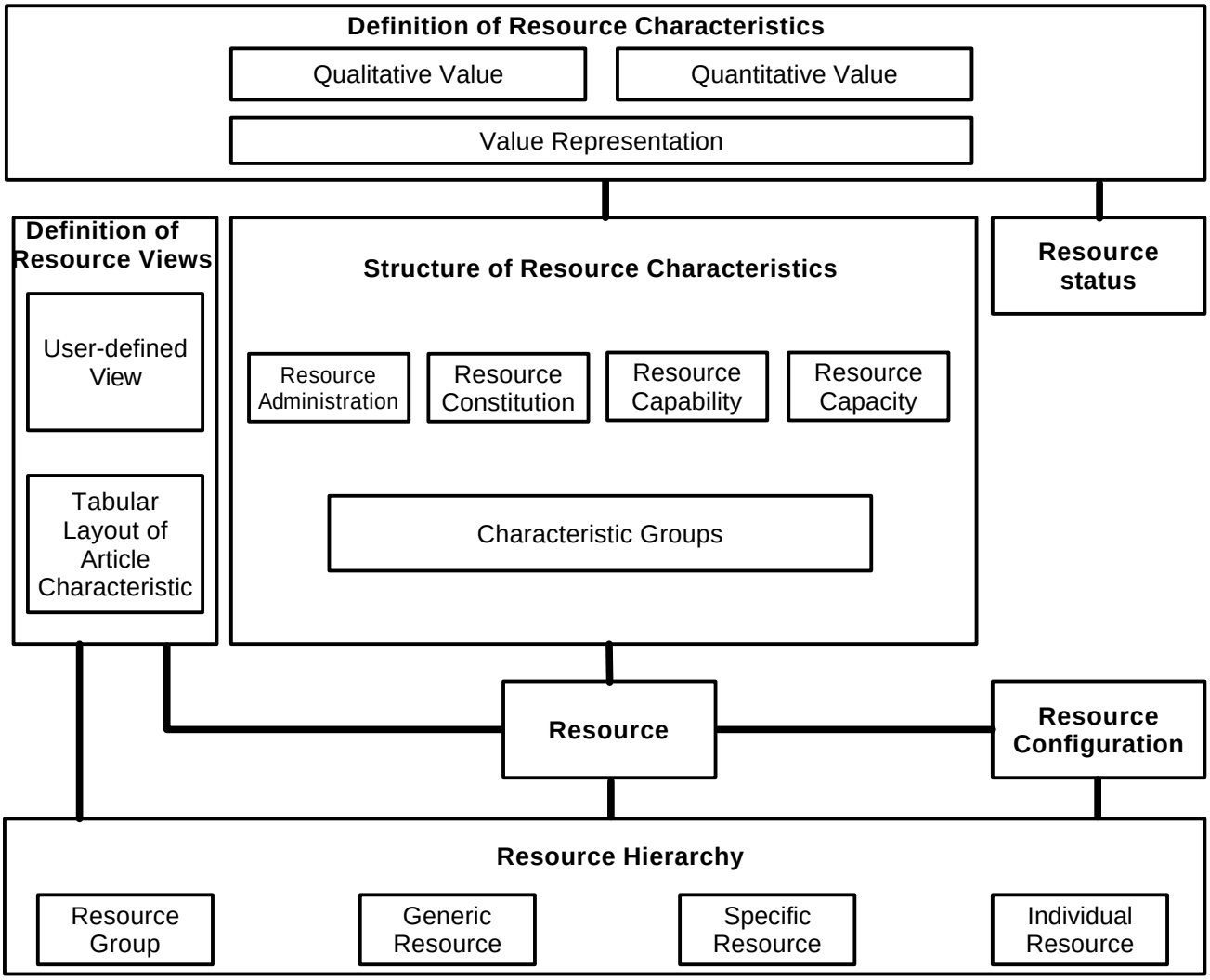

Figure 2 - Structure of resource information model [2]

For resource usage management purposes a `resource_characteristic` is appointed which comprises information about the actual `resource_status`. The attribute classification enables the assignment of a `resource_characteristic` to a `resource_characteristic_group`, distinguishing into:

— `resource_administration ;`

— resource_capability ;

— resource_constitution;

— resource_capacity.

A resource_administration represents a group of characteristics describing administrative information on manufacturing resources. A resource_capability defines a group of characteristics specifying manufacturing resources under functional aspects. In particular this comprises the specification of resource-specific manufacturing processes. A resource_constitution represents a group of characteristics describing the constitution of manufacturing resources. A resource_capacity defines a group of characteristics dealing with job scheduling related resource data, e.g. the workload of an individual_resource.

A definition of a resource_view is derived by a specific aggregation of resource_characteristics. A resource_view is assigned to a generic_resource and can either be represented by a resource_tabular_layout_of_article_characteristic, e.g. regarding to DIN 4000, or by a resource_user_defined_view.

Representing a resource hierarchy and defining a resource view form the first instantiation level of the generic model. A partial model has to be derived in order to configure the model regarding to user-specific demands. Instantiating resource_group and generic_resource, including the definition of a resource_view generate it. The actual instantiation of the model with physical resource data is based on the partial model. Physical values of manufacturing resource characteristics are represented by resource_representation which can either be qualitative or quantitative values.
A resource_status is assigned to each individual_resource. A status is defined by a resource_status_type which provides feedback information on the state of manufacturing resources. Moreover a resource_status has a time_reference to date which is represented in the date_time_schema of ISO10303-41.

7 Relation to ISO 15531-2x series and ISO 15531-4x series

Some of the information to be represented in the ISO 15531-3x series comes from the environment of the enterprise addressed by ISO 15531-21 and is linked to information represented in resource characteristics.

> EXAMPLE - Information exchanged with suppliers on resource maintenance, with customers or suppliers on resource administration.

Data exchanges during the production cycle are strongly related to system management and to time and flow models addressed by ISO 15531-4x series of parts. Direct linkages from the Resource Information Model of ISO 15531-32 to resource status and time schemas in ISO 15531-4x series of parts are established.

In that way, information on internal system management as described in ISO 15531-4x series of parts, information on resources usage management, as in the parts of ISO 15531-3x series as well as those to be exchanged outside of the company (part ISO 15531-21), are fully consistent.

Annexe A
(Informative)

Relation of ISO 15531-3x series of parts with other related standards

A.1 Relation to other standards

Appropriate related standards as well as standardisation efforts have been considered in this standard. That concerns ISO 10303, ISO 13584, EDIFACT, and standards or efforts dealing with enterprise modelling such as ISO FDIS 14258, CEN/CENELEC ENV 40003, CEN/CENELEC ENV 12204. Have also been taken in account works in progress within the ISO TC184/SC5/WG1 and CEN TC310/WG1, as well as other related standardisation work such as work in progress in the ISO TC29/WG34 on "Cutting tools" data exchange. ISO 15531-3x series of parts supports this related work.

During manufacturing processes, people use data defined by the designers, and they do not have to redefine work already done. Raw material, or intermediate products, clearly product-related, are within the scope of ISO 10303. These items are out of the scope of ISO 15531-3x series. Some data about components has to be exchanged during the production process inside the factory and/or outside the factory (i.e. through the purchasing department). This is within the scope of ISO 13584. Moreover many other kinds of data, which are defined in other standardisation group are used, shared or exchanged during the production process inside the company.

> EXAMPLE - Work in progress in ISO TC29/WG24 on "Cutting Tools" (ISO 13399 Cutting tool representation and exchange), ISO TC184 SC1 WG7 (ISO 14649 Data model for CNC controllers).

The models, constructs and data representations provided by 15531-3x series are checked to be consistent with those provided by ISO 10303 and ISO 13584 in order to make integration in manufacturing easier and to ensure interoperability all over the production process. This means, in particular, that this standards using EXPRESS language, is fully compliant with the ISO 10303 architecture.

Moreover, resource usage management will be one of the tools of the manufacturing integration process and is checked to be compliant with upper level integration tools such as those developed in the field of Enterprise Modelling by the ISO TC184/SC5/WG1 (ISO 14258) CEN TC 310 WG1 (ENV 12204).

Specific portions of the 15531-3x series address aspects that may be different from that adopted in other standards. ISO 15531-3x series of parts may use enterprise entity that are required for the optimal description of information and processes and may be proposed as "common resources" to ISO TC 184/SC4:

— Most of the time, parts lists are re-built by the manufacturing management. This is due to the top-down approach of the design function, from the whole product to assemblies and spare parts, while

manufacturing management has a bottom-up approach, based on production in pulled flow which takes a given level of inventories and resources availability into account.

— The process plan is a specific way to use ISO 10303 to define products undergoing transformation during manufacturing. The link with the product to be made (thus with ISO 10303) is obvious (see ISO 10303-49). Available resources and tools, and their capabilities and capacities are integrally linked and therefore common to both activities.

Except for very specific cases of prototypes, or unique parts, most of the data used during manufacturing cannot be defined at the product design stage, because the data is determined by situations evolving with time, and also by variable characteristics and capabilities.

ISO 10303, and ISO 15531-3x series assesses items common to both in different ways and from different viewpoints. As a result, the ISO 15531-3x series, Enterprise Modelling standards and ISO TC29 standards do not overlap. There is a very strong relationship between these standardisation efforts and a need for close co-ordination.

The following are specific references and relationships:
ISO 13399 can be used for the initial parts of ISO 15531-32,
ISO 10303 (AP 213 and AP 224) could reference entities of ISO 15531-32,
ISO 14649 could reference to ISO 15531-32 entities.

A.2 Use of the standard

This standard will pay special attention to the description of the resource usage management, and the configuration of resources. Selection of resource activities would use the data that are described by the data modelling method presented by this standard. The resource manager has to be supplied with all necessary information at all times to fulfil its tasks. The standard is allows access to this information under a standardised form independent of the kind of resources or processes.

The above-described model serves as a basis for a standard but is shown in only two dimensions. It corresponds to only one aspect, resource usage management. By building a generic schema dedicated to specific viewpoints such as cost elements, maintenance, and quality, a specialised set of application oriented standards or application protocols can be developed.

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